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DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/ MANAGEMENT/COMMERCIAL PRACTICE — OCTOBER, 2019

RENEWABLE ENERGY SOURCES

[*Time* : 3 hours

(Maximum marks : 100)

PART — A

(Maximum marks : 10)

Marks

I Answer *all* questions in one or two sentences. Each question carries 2 marks.

1. Name any two Piezo - electric materials.
2. List any two fuels used in fuel cells.
3. Name any two instruments used to measure solar radiation.
4. State any two applications of wind energy.
5. State the function of charge controller. (5×2 = 10)

PART — B

(Maximum marks : 30)

II Answer any *five* of the following questions. Each question carries 6 marks.

1. List the various Geo thermal power plants.
2. List out any six advantages of fuel cells.
3. List the application of solar energy.
4. Explain passive solar space heating.
5. Briefly explain the wind energy storage.
6. Explain constant speed constant frequency wind scheme.
7. Describe the working of buck converter. (5×6 = 30)

Marks

PART — C

(Maximum marks : 60)

(Answer *one* full question from each unit. Each full question carries 15 marks.)

UNIT — I

III (a) Explain working of MHD plant with the help of neat sketch. 7

(b) List the merits and demerits of wind power plants. 8

OR

IV (a) Explain open cycle OTEC Power plants. 7

(b) Explain single process biogas digester with a neat sketch. 8

UNIT — II

V (a) Explain the focusing type solar collector with the figure. 7

(b) Describe the domestic water heating system with the help of a figure 8

OR

VI (a) Explain the working of solar power plant with a neat sketch. 7

(b) Briefly explain solar pond with necessary figure. 8

UNIT — III

VII (a) Estimate the power produced by a wind turbine. 7

(b) Enumerate the basic components of wind energy conversion systems. 8

OR

VIII (a) Classify wind energy conversion systems. 7

(b) Differentiate between horizontal and vertical axis wind turbines. 8

UNIT — IV

IX (a) Draw and explain the block diagrams of wind energy system. 7

(b) Explain briefly SPV system with necessary block diagram. 8

OR

X (a) Explain the concepts of Maximum power point tracking. 7

(b) Explain stand alone wind energy systems. 8

Sub code: 5035 Register no:……...

Revision: 2015 Signature: …….....

MALABAR POLYTECHNIC CAMPUS CHERPULASSERY

DIPLOMA EXAMINATION - OCT 2019

FIFTH SEMESTER DIPLOMA IN ELECTRICAL AND ELECTRONICS ENGINEERING

RENEWABLE ENERGY SOURSES –ANSWER KEY

Time: 3 Hrs

Max marks: 100

PART A

I. Answer the following questions in one or two sentences each carries 2 mark.

1. Some examples of piezoelectric materials are PZT (also known as lead zirconate titanate), barium titanate, and lithium niobate. These man-made materials have a more pronounced effect (better material to use) than quartz and other natural piezoelectric materials

2. The primary fuels that can be directly utilized within fuel cell stacks today are hydrogen, carbon monoxide, methanol, and dilute light hydrocarbons like methane, depending upon the fuel cell type. The table below presents various fuel cell types and the primary fuels that they are amenable to using.

3. There are two important types of instruments to measure solar radiation:

Pyrheliometer is used to measure direct beam radiation at normal incidence.

...

Pyranometer is used to measure total hemispherical radiation - beam plus Diffuse - on a horizontal surface. ...

Photoelectric sunshine recorder.

4. A windmill is a structure that converts the energy of wind into rotational energy by means of vanes called sails or blades. Centuries ago, windmills usually were used to mill grain (gristmills), pump water (wind pumps), or both. There are windmills that convert the rotational energy directly into heat..

5. A charge controller or charge regulator is basically a voltage and/or current regulator to keep batteries from overcharging. It regulates the voltage and current coming from the solar panels going to the battery. ... Most batteries need around 14 to 14.5 volts to get fully charged..

PART B

II. Answer the following questions. Each carries 6 marks.

1. Dry steam plants use steam directly from a geothermal reservoir to turn generator turbines. ...

Flash steam plants take high-pressure hot water from deep inside the earth and convert it to steam to drive generator turbines.

2. Fuel cells have a higher efficiency than diesel or gas engines.

Most fuel cells operate silently, compared to internal combustion .

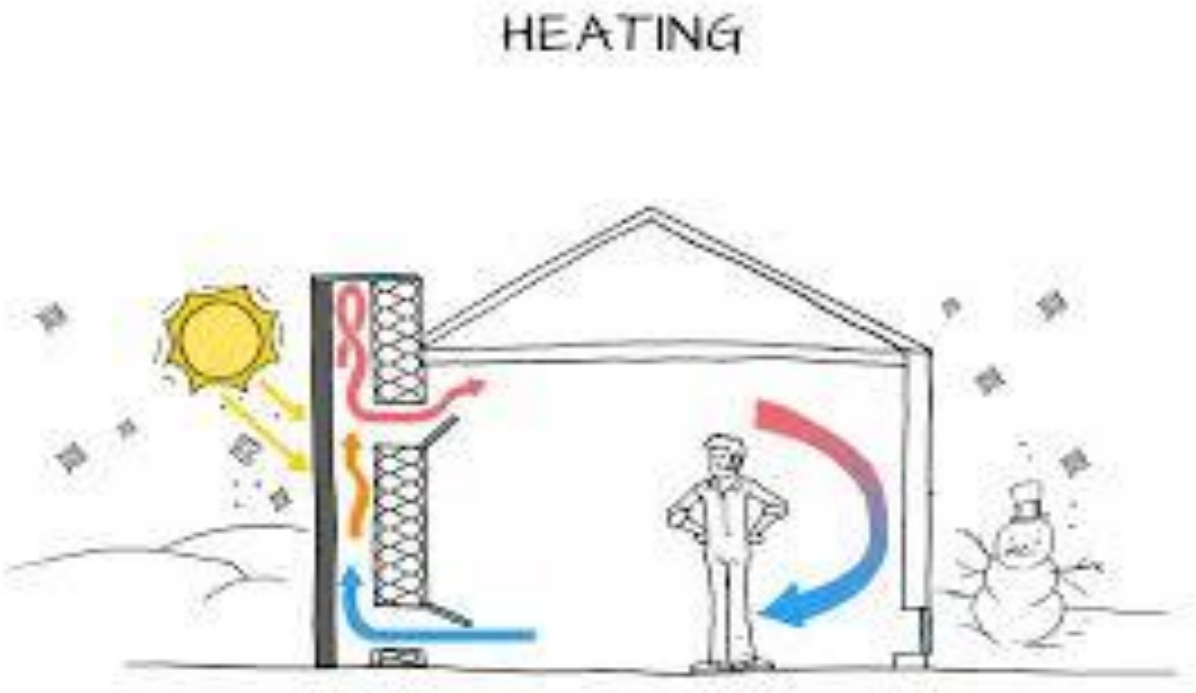
Fuel cells can eliminate pollution caused by burning fossil fuels;

Hydrogen fuel cells are cleaner and more efficient than traditional combustion-based engines and power plants. Hydrogen and fuel cells can also be used in mobile applications to power vehicles and mobile power packs.
The benefits of fuel cells are: Reduced greenhouse gas emissions.

3. Solar energy is used to power radio and TV stations. It is also used to supply power to lighthouse and warning light for aircraft. Solar energy can be used for power generation in remotely situated places like schools, homes, clinics and buildings. Water pumps run on solar energy in remote areas

4. In simple terms, a passive solar home collects heat as the sun shines through south-facing windows and retains it in materials that store heat, known as thermal mass. ... Well-designed passive solar homes also provide daylight all year and comfort during the cooling season through the use of nighttime ventilation

Passive solar design refers to the use of the sun's energy for the heating and cooling of living spaces by exposure to the sun. When sunlight strikes a building, the building materials can reflect, transmit, or absorb
the solar radiation.



5. Through several different storage processes, excess energy can be stored to be used during periods of lower wind or higher demand.

Battery Storage

Electrical batteries are commonly used in solar energy applications and can be used to store wind generated power. Lead acid batteries are a suitable choice as they are well suited to trickle charging and have a high electrical output charging efficiency.

Compressed Air Storage

Wind turbines can use excess power to compress air, this is usually stored in large above-ground tanks or in underground caverns. When required the compressed air can be used through direct expansion into a compressed air motor. It can also be injected in an internal combustion turbine, where it is burnt with fuel to provide mechanical energy which then powers a generator.

Hydrogen Fuel Cells

Hydrogen fuel cells can also be used to store excess energy. A hydrogen generator is used to electrolyse water using power generated from the wind turbine, storing the resulting hydrogen and converting it back to electricity using a fuel cell power system when needed.

Pumped Storage

Pumped storage is associated with hydroelectric power generation but is yet to be used with wind power generation. Water could theoretically be pumped up to an elevated reservoir utilizing excess generated power and then be used to drive a water turbine when required. The technology is proven and has been used for centuries, giving a relatively high overall efficiency of 70%. Existing hydroelectric power plants could be utilized if they are in an area suitable for a wind farm.

6.

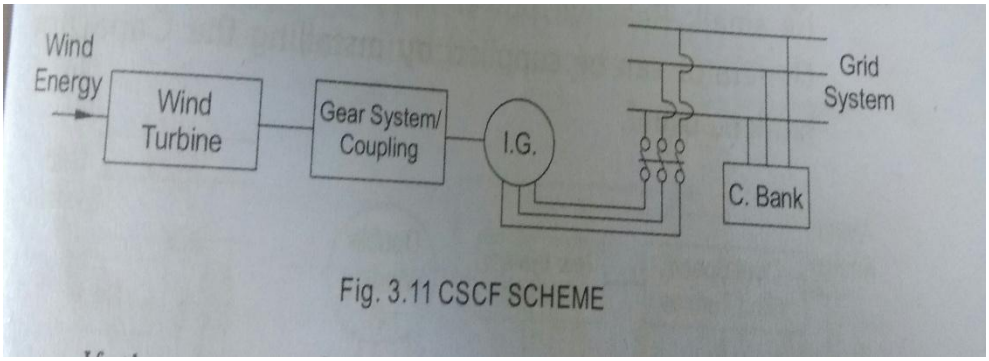


Fig. 3.11 CSCF SCHEME

This system is used at large power production that given to grid

Synchronous generator (alternator) or squirrel cage Induction generators (IG) used

Stator connected to grid,

Rotor attain constant speed machine provide constant frequency power to grid

IG are mostly used – simpler, economical, easy to operate, control and maintains

Capacitor bank used to avoid reactive power burden to grid

7. A Buck converter steps down a DC voltage from the input to the output. The circuit operation depends on the conduction state of the MOSFET: On-state: The current through the inductor increases and the diode blocks. ... Energy is

transferred from the inductor to the capacitor resulting in a decreasing inductor current.

A buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while stepping up current) from its input (supply) to its output (load).

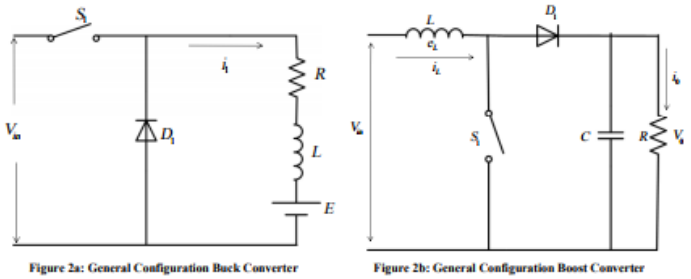


Figure 2a: General Configuration Buck Converter

Figure 2b: General Configuration Boost Converter

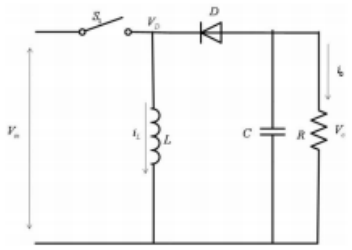


Figure 2c: General Configuration Buck-Boost Converter

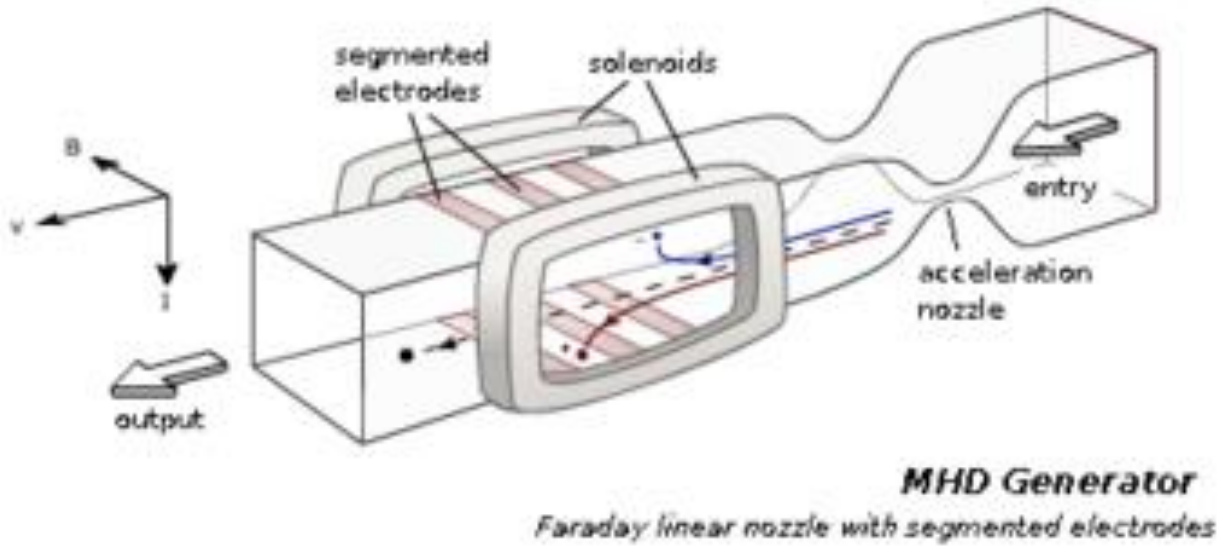
PART-C

UNIT-1

(a). Magneto hydrodynamic generator

A magneto hydrodynamic generator (MHD generator) is a magneto hydrodynamic device that transforms thermal energy and kinetic energy into electricity. MHD generators are different from traditional electric generators in that they operate at high temperatures without moving parts. MHD was developed because the hot exhaust gas of an MHD generator can heat the boilers of a steam power plant, increasing overall efficiency.

An MHD generator, like a conventional generator, relies on moving a conductor through a magnetic field to generate electric current. The MHD generator uses hot conductive plasma as the moving conductor. The mechanical dynamo, in contrast, uses the motion of mechanical devices to accomplish this. MHD generators are technically practical for fossil fuels, but have been overtaken by other, less expensive technologies, such as combined cycles in which a gas turbine's or molten carbonate fuel cell's exhaust heats steam to power a steam turbine.



(b), Advantages of Wind Power

Wind power is cost-effective. ...
Wind creates jobs. ...
Wind enables U.S. industry growth and U.S. competitiveness. ...
It's a clean fuel source. ...
Wind is a domestic source of energy. ...
It's sustainable. ...
Wind turbines can be built on existing farms or ranches.

Disadvantages of Wind Energy

The **Wind** Fluctuates. **Wind energy** has a similar drawback to solar **energy** in that it is not constant. ...
Wind Turbines Are Expensive. Although costs are reducing, **wind turbines** are still very expensive. ...
Wind Turbines Pose a Threat to Wildlife. ...
Wind Turbines Are Noisy. ...
Wind Turbines Create Visual Pollution.

OR

(a)

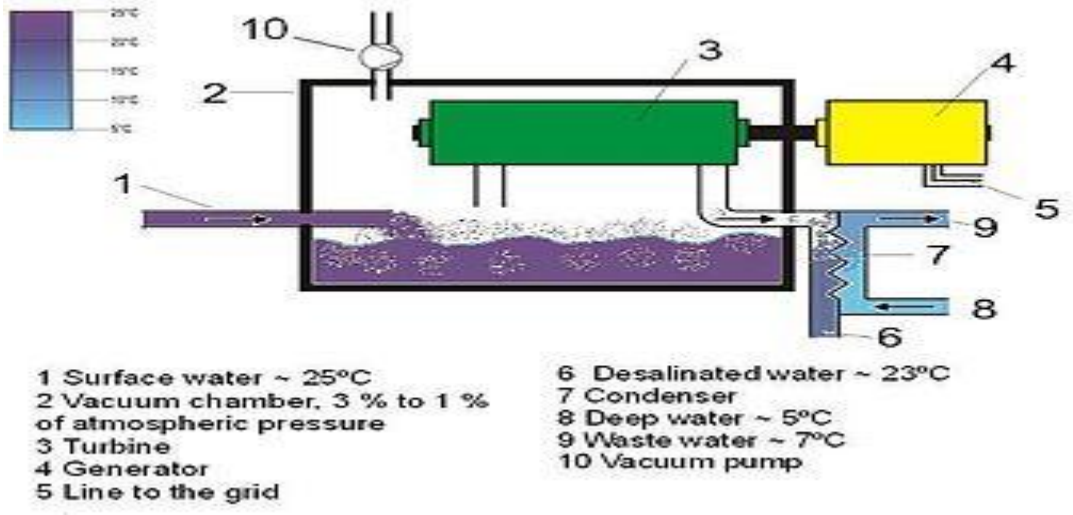
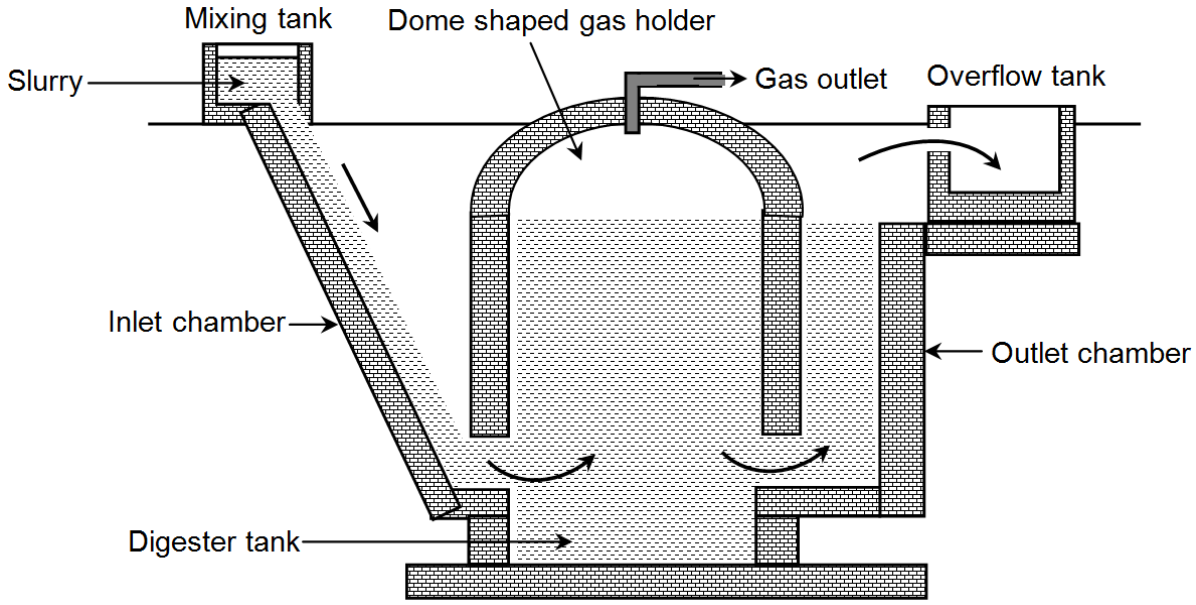


Diagram of an open cycle OTEC plant

Open-cycle OTEC uses warm surface water directly to make electricity. The warm seawater is first pumped into a low-pressure container, which causes it to boil. In some schemes, the expanding vapour drives a low-pressure turbine attached to an electrical generator. The vapour, which has left its salt and other contaminants in the low-pressure container, is pure fresh water. It is condensed into a liquid by exposure to cold temperatures from deep-ocean water. This method produces desalinized fresh water, suitable for drinking water, irrigation or aquaculture.

(b) The fixed dome type bio gas plant consists of a closed underground digester tank made up of bricks which has a dome shaped roof also made up of bricks. This dome shape roof of the digester tank functions as gas holder and has an outlet pipe at the top to supply gas to homes.

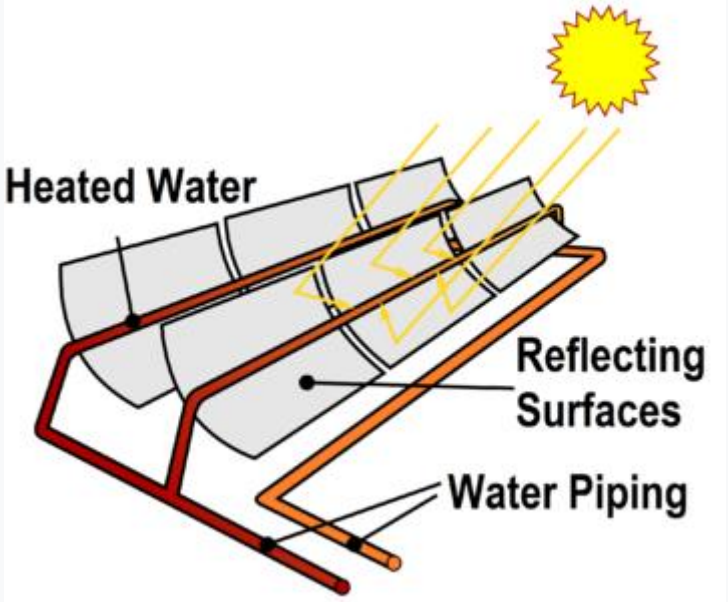
Slurry is prepared by mixing water in cattle dung in equal proportion in mixing tank. The slurry is then sent into the digester tank with the help of inlet chamber. It should be noted that slurry is fed into the digester tank up to the point where the dome of the roof starts. Inside the digester tank, the complex carbon compounds present in the cattle dung breaks into simpler substances by the action of anaerobic microorganisms in the presence of water. This anaerobic decomposition of complex carbon compounds present in cattle dung produces bio gas and gets completed in about 60 days. The bio gas so produced starts to collect in dome shaped roof of bio gas plant and is supplied to homes through pipes. The spent slurry is replaced from time to time with fresh slurry to continue the production of bio gas.



UNIT-2

(a),

Line Focus Collectors



These collectors, sometimes known as parabolic troughs, use highly reflective materials to collect and concentrate the heat energy from solar radiation.[8] These collectors are composed of parabolically shaped reflective sections connected into a long trough.[2] A pipe that carries water is placed in the center of this trough so that sunlight collected by the reflective material is focused onto the pipe, heating the contents. These are very high powered collectors and are thus generally used to generate steam for Solar thermal power plants and are not used in residential applications. These troughs can be extremely effective in generating heat from the Sun, particularly those that can pivot, tracking the Sun in the sky to ensure maximum sunlight collection.[2]

Point Focus Collectors

These collectors are large parabolic dishes composed of some reflective material that focus the Sun's energy onto a single point. The heat from these collectors is generally used for driving Stirling engines.[2] Although very effective at collecting sunlight, they must actively track the Sun across the sky to be of any value. These dishes can work alone or be combined into an array to gather even more energy from the Sun.[10]

Point focus collectors and similar apparatuses can also be utilized to concentrate solar energy for use with Concentrated photovoltaics. In this case, instead of producing heat, the Sun's energy is converted directly into electricity with high efficiency photovoltaic cells designed specifically to harness concentrated solar energy.

(b),

Direct systems circulate water through solar collectors where it is heated by the sun. ... The sun's thermal energy heats the fluid in the solar collectors. Then, this fluid passes through a heat exchanger in the storage tank, transferring the heat to the water. The non-freezing fluid then cycles back to the collectors.

OR

(a),

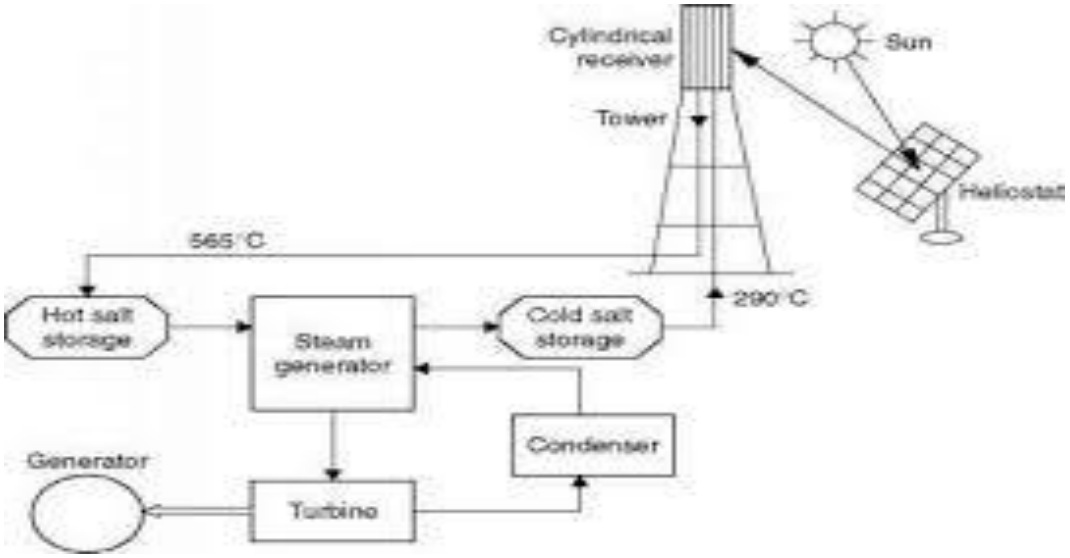
.

. Solar thermal power generation systems collect and concentrate sunlight to produce the high temperature heat needed to generate electricity. All solar thermal power systems have solar energy collectors with two main components: *reflectors* (mirrors) that capture and focus sunlight onto a *receiver*. In most types of systems, a heat-transfer fluid is heated and circulated in the receiver and used to produce steam. The steam is converted into mechanical energy in a turbine, which powers a generator to produce electricity. Solar thermal power systems have tracking systems that keep sunlight focused onto the receiver throughout the day as the sun changes position in the sky.

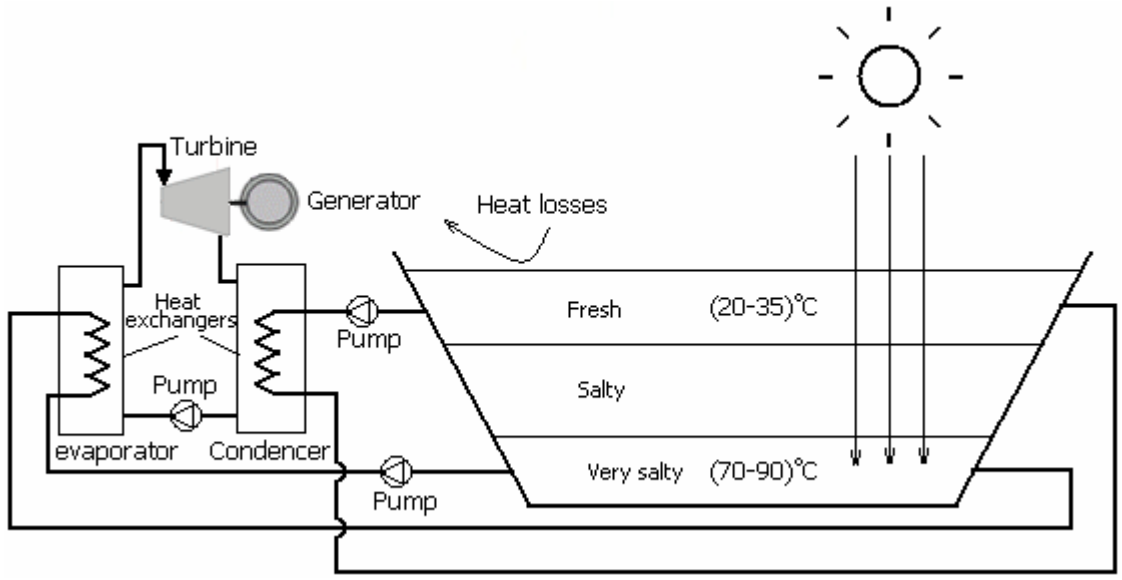
Types of concentrating solar thermal power plants

There are three main types of concentrating solar thermal power systems:

- Linear concentrating systems, which include parabolic troughs and linear Fresnel reflectors
- Solar power towers
- Solar dish/engine systems



(b), solar pond



A solar pond is simply a pool of saltwater which collects and stores solar thermal energy. The saltwater naturally forms a vertical salinity gradient also known as a "halocline", in which low-salinity water floats on top of high-salinity water. The layers of salt solutions increase in concentration (and therefore density) with depth. Below a certain depth, the solution has a uniformly high salt concentration

When the sun's rays contact the bottom of a shallow pool, they heat the water adjacent to the bottom. When water at the bottom of the pool is heated, it becomes less dense than the cooler water above it, and convection begins. Solar ponds heat water by impeding this convection. Salt is added to the water until the lower layers of water become completely saturated. High-salinity water at the bottom of the pond does not mix readily with the low-salinity water above it, so when the bottom layer of water is heated, convection occurs separately in the bottom and top layers, with only mild mixing between the two. This greatly reduces heat loss, and allows for the high-salinity water to get up to 90 °C while maintaining 30 °C low-salinity water. This hot, salty water can then be pumped away for use in electricity generation, through a turbine or as a source of thermal energy.

UNIT-3

(a),

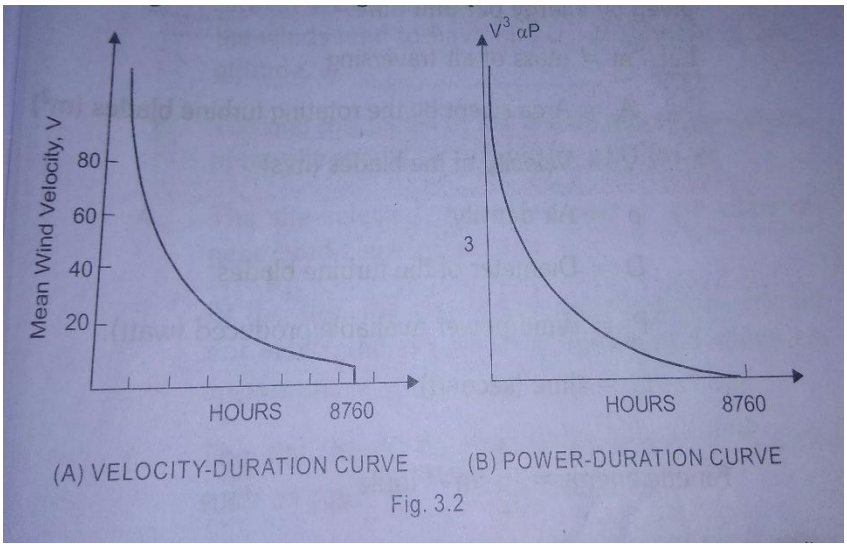


Fig. 3.2

Energy Estimation : Velocity-duration and power (aV3) duration curves ace useful for establishing the wind energy potential of a region and the design wind spend.

- Wind velocity varies at different location , so estimation taken in terms of period or duration
- Wind data represent in form of

1. Isovents: contour drawn between constant average wind velocity areas (m/s)
wind map represent annual velocity zones

2. isodynes : contour drawn between constant wind power areas (watt/m2)
map shows yearly average power

The wind turbine or windmill works on the principle of converting kinetic energy of the wind to mechanical energy. We know the power is given by energy per unit time.

Let m = mass of air traversing

A = Area swept by the rotating turbine blades (m2)

v = Velocity of the blades (ms)

p = Air density

D = Diameter of the turbine blades

P = Wind power available / produced (watt)

t = time (second)

Kinetic energy I = ½ * mV2 joule

= ½ * (p x AV x t) V2 joule

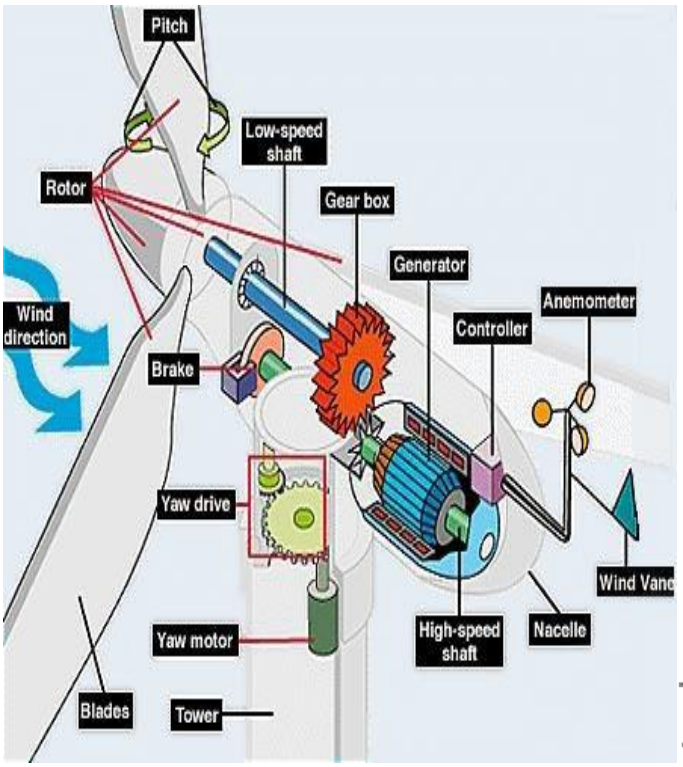
= ½ * p A V3 t joule

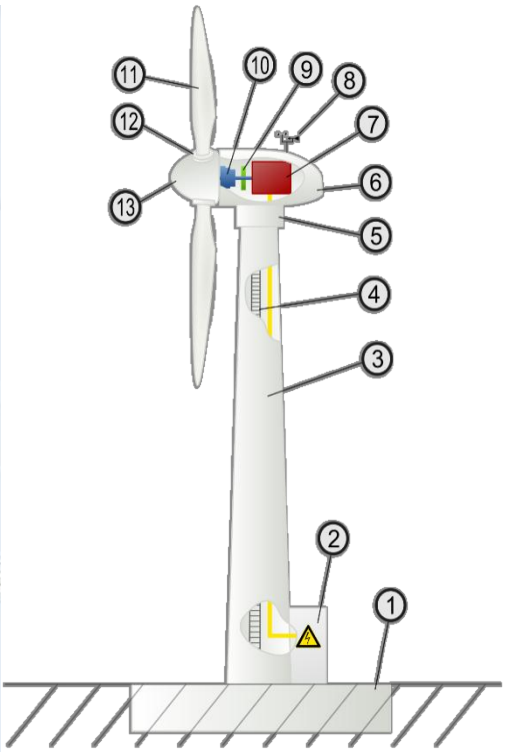
= ½ * p (pi/4) D2 V3 t joule or watt-sec (kwh)

Pw = Energy / time = 1/8 p (pi) D2 V3 watt

(b), Components of wind energy converting system

Wind turbines harness the power of the wind and use it to generate electricity. Simply stated, a wind turbine works the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The energy in the wind turns two or three propeller-like blades around a rotor. The rotor is connected to the main shaft, which spins a generator to create electricity. This illustration provides a detailed view of the inside of a wind turbine, its components, and their functionality.





Turbine

- Horizontal axis turbines are mostly used today, It contain 2 or 3 blades
- Blades are made of composite material like fiber glass
- Amount of energy produced depend on swept area (diameter of rotor). ie quantity of air intercepted on turbine.
- Tail keep the turbine facing into the wind

2. Tower

- Height increase then power production also increase
- 2 types of towers
  1. self supporting / free standing

2. guyed type

- Home wind system guyed type towers are used
- It is least expensive , easier to install , less space to accommodate
- Tilt down guyed also used. It Is more expensive
- Easy to maintain less weight turbine under 10KW
- This towers can lowered to ground when hazardous weather or hurricanes
- Self supporting are more expensive
- usually used at wind farms for more power production

Anemometer:
Measures the wind speed and transmits wind speed data to the controller.

Blades:
Lifts and rotates when wind is blown over them, causing the rotor to spin. Most turbines have either two or three blades.

Brake:
Stops the rotor mechanically, electrically, or hydraulically, in emergencies.

Controller:
Starts up the machine at wind speeds of about 8 to 16 miles per hour (mph) and shuts off the machine at about 55 mph. Turbines do not operate at wind speeds above about 55 mph because they may be damaged by the high winds.

Gear box:
Connects the low-speed shaft to the high-speed shaft and increases the rotational speeds from about 30-60 rotations per minute (rpm), to about 1,000-1,800 rpm; this is the rotational speed required by most generators to produce electricity. The gear box is a costly (and heavy) part of the wind turbine and engineers are exploring "direct-drive" generators that operate at lower rotational speeds and don't need gear boxes.

Generator:
Produces 60-cycle AC electricity; it is usually an off-the-shelf induction generator.

High-speed shaft:
Drives the generator.

Low-speed shaft:
Turns the low-speed shaft at about 30-60 rpm.

Nacelle:
Sits atop the tower and contains the gear box, low- and high-speed shafts, generator, controller, and brake. Some nacelles are large enough for a helicopter to land on.

Pitch:
Turns (or pitches) blades out of the wind to control the rotor speed, and to keep the rotor from turning in winds that are too high or too low to produce electricity.

Rotor:
Blades and hub together form the rotor.

Tower:
Made from tubular steel (shown here), concrete, or steel lattice. Supports the structure of the turbine. Because wind speed increases with height, taller towers enable turbines to capture more energy and generate more electricity.

Wind direction:
Determines the design of the turbine. Upwind turbines—like the one shown here—face into the wind while downwind turbines face away.

Wind vane:
Measures wind direction and communicates with the yaw drive to orient the turbine properly with respect to the wind.

Yaw drive:
Orients upwind turbines to keep them facing the wind when the direction changes. Downwind turbines don't require a yaw drive because the wind manually blows the rotor away from it.

Yaw motor:
Powers the yaw drive.

OR

(a), **Classification of Wind energy conversion system**

Horizontal Axis Wind Turbine

The Horizontal Axis Wind Turbines require a "yaw" mechanism to turn the turbine against the wind direction in order to harvest the wind energy. They are usually installed high up above ground level on a tower in order to harvest the ample wind energy up in the sky. There are 2 types of blades that are used on these turbines. They are the Drag type and Lifting type.

The Drag type blades are typically what you see on an old Dutch wind mill. The blades are generally flat which are hit by the wind to cause the rotation. This type of design is great for operation at very low wind speed and can develop a lot of torque to perform operation. However, they cannot operate at medium to high wind speed.

The Lift type blades are used in most modern wind turbines and on airplanes. The design uses the aerodynamic properties of the blade profile to provide lift force to turn the blades such that the wind turbines can harvest the wind energy at high wind speed. With this design, the rich energy in high wind speed area can then be harvested efficiently.

Vertical Axis Wind Turbine

The Vertical Axis Wind Turbines do not require a "yaw" mechanism to harvest the wind energy. Since the blades rotate 360 degree on the vertical shaft of the wind turbines, wind of any direction can turn the turbine. The turbines are usually installed on or close to the ground level. However, the wind speed is always lower than that in the upper sky. There are also 2 types of blades that are used on these turbines. They are the Drag type and Lift type.

The Drag type blades are used on the Savonius wind turbine. The blades are generally of flat type with large area. They are hit by the wind to cause the rotation. This type of design is good for operation at low to medium wind speed to generate electricity. However, the capacity of this type of wind turbines is limited to small scale because it is difficult to make the large area of blades required.

The Lift type of blades is used on the Darrius or "egg beater" wind turbine. The design uses the aerodynamic properties of the blade profile to provide lift force to turn the blades such that the wind turbines can harvest the wind energy at high wind speed. The blade shapes are different than the lift type used on the Horizontal Axis Wind Turbines.

Wind energy conversion devices can be broadly categorized into two types according to their axis alignment. They are as follows.

1. HorizontaJ Axis wind mills or turbines

a. Dutch type grain grinding or sail type wind mills

b. Multiblade type wind mill

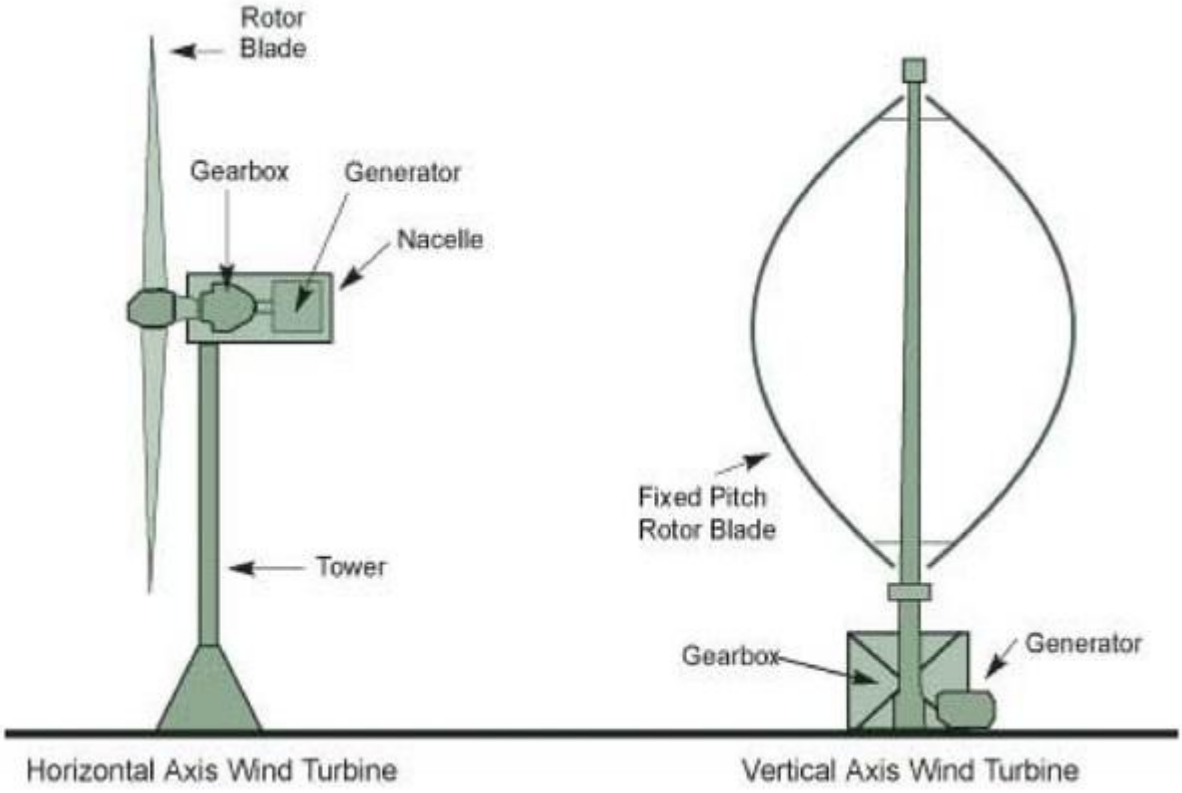
c. High speed propeller type wind mill.

2. Vertical Axis wind mills or turbines.

a Savonius (rotor) type wind mill

b. Darrieus (rotor) type wind mill

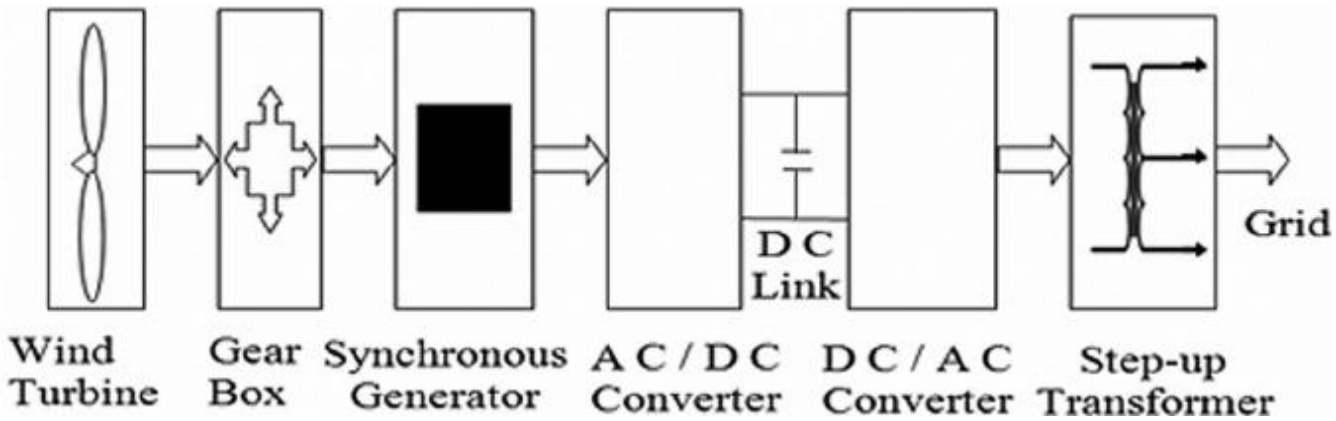
(b),



The horizontal-axis turbine typically has a three-blade vertical propeller that catches the wind face-on. The vertical turbine has a set of blades that spins around a vertical axis. Each type has its advantages and disadvantages and is suited to different environments. More maintenance – While a VAWT has fewer components that can wear and require repair, the forces acting on the machine are more turbulent than those on a HAWT. When a HAWT is pointed in the right direction, the blades are also pitched optimally

UNIT-4

(a),



1. Wind (moving air that contains kinetic energy) blows toward the turbine's rotor blades.
2. The rotors spin around, capturing some of the kinetic energy from the wind, and turning the central drive shaft that supports them. Although the outer edges of the rotor blades move very fast, the central axle (drive shaft) they're connected to turns quite slowly.
3. In most large modern turbines, the rotor blades can swivel on the hub at the front so they meet the wind at the best angle (or "pitch") for harvesting energy. This is called the pitch control mechanism. On big turbines, small electric motors or hydraulic rams swivel the blades back and forth under precise electronic control. On smaller turbines, the pitch control is often completely mechanical. However, many turbines have fixed rotors and no pitch control at all.
4. Inside the nacelle (the main body of the turbine sitting on top of the tower and behind the blades), the gearbox converts the low-speed rotation of the drive shaft (perhaps, 16 revolutions per minute, rpm) into high-speed (perhaps, 1600 rpm) rotation fast enough to drive the generator efficiently.
5. The generator, immediately behind the gearbox, takes kinetic energy from the spinning drive shaft and turns it into electrical energy. Running at maximum capacity, a typical 2MW turbine generator will produce 2 million watts of power at about 700 volts.
6. Anemometers (automatic speed measuring devices) and wind vanes on the back of the nacelle provide measurements of the wind speed and direction.
7. Using these measurements, the entire top part of the turbine (the rotors and nacelle) can be rotated by a yaw motor, mounted between the nacelle and the tower, so it faces directly into the oncoming wind and captures the maximum amount of energy. If it's too windy or turbulent, brakes are applied to stop the rotors from turning (for safety reasons). The brakes are also applied during routine maintenance.
8. The electric current produced by the generator flows through a cable running down through the inside of the turbine tower.
9. A step-up transformer converts the electricity to about 50 times higher voltage so it can be transmitted efficiently to the power grid (or to nearby buildings or communities). If the electricity is flowing to the grid, it's converted to an even higher voltage (130,000 volts or more) by a substation nearby, which services many turbines.
10. Homes enjoy clean, green energy: the turbine has produced no greenhouse gas emissions or pollution as it operates.
11. Wind carries on blowing past the turbine, but with less speed and energy (for reasons explained below) and more turbulence (since the turbine has disrupted its flow).

(b),

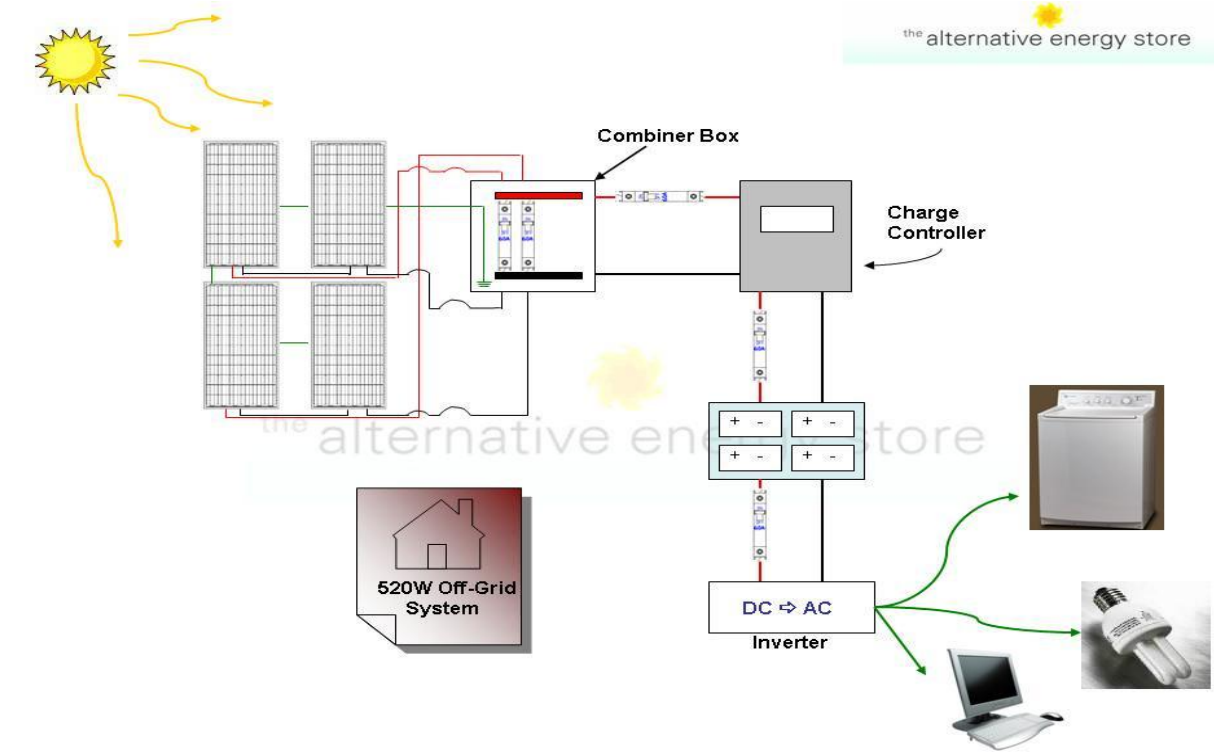
A simple solar electric system consists of five parts, as shown on figure above. The 5 parts are solar module, rechargeable batteries, control unit, distribution of electricity and electrical appliances.

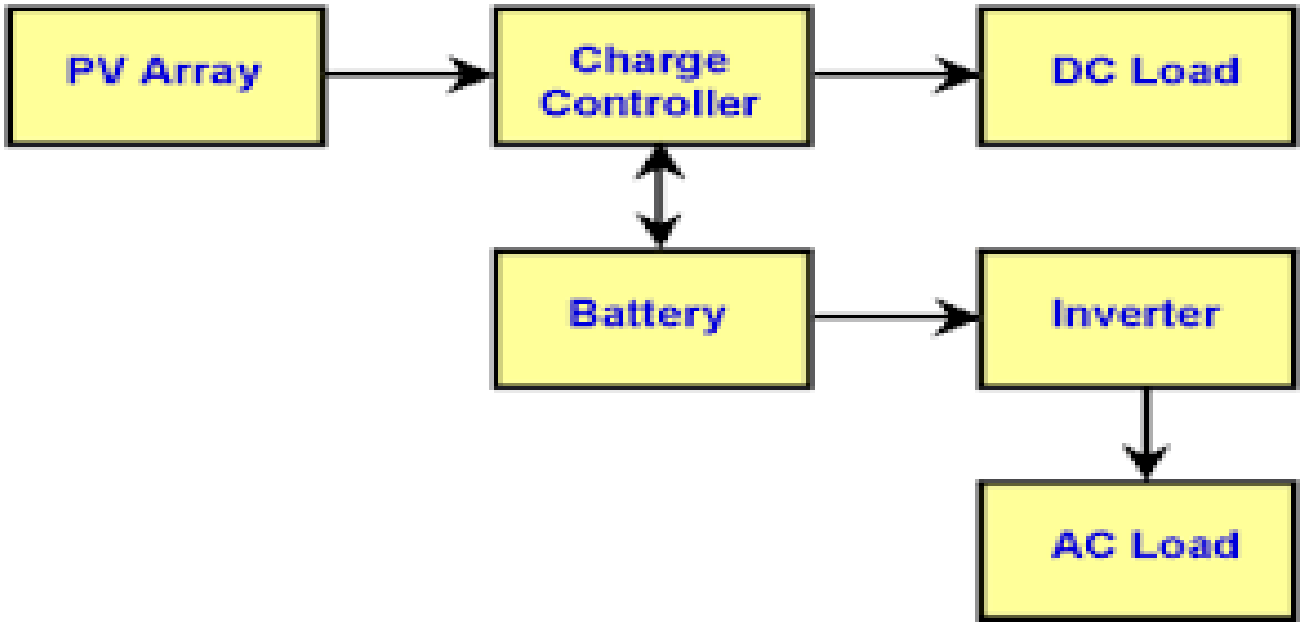
Solar module is used to generate electricity from sunlight. When electricity is generated, the control unit will take part. Its function is to switch the loads manually or automatically, protect the batteries and wiring, monitor the performance of the system and give warnings when faults happen in the system. Some simpler system may not have control unit. The rechargeable batteries are connected directly to the solar module.

The rechargeable batteries are used to store electricity for later use at night and during cloudy periods. Normally, twelve-volt (12V) Lead-acid batteries, similar to the ones in cars and trucks, are used.

The distribution of electricity is direct current (DC) 12-24V. It is much less dangerous than mains voltages, which is 100-240V. Besides, its wiring is less complicated. Finally, the generated electricity can be

connected to the electrical appliances. These appliances normally work in DC. They may need adaptor and inverter if work in AC.





PV Modules - convert sunlight instantly into DC electric power.

Inverter - converts DC power into standard AC power for use in the home, synchronizing with utility power whenever the electrical grid is distributing electricity.

Battery - stores energy when there is an excess coming in and distribute it back out when there is a demand. Solar PV panels continues to re-charge batteries each day to maintain battery charge.

Utility Meter - utility power is automatically provided at night and during the day when the demand exceeds your solar electric power production.

The utility meter actually spins backwards when solar power production exceeds house demand, allowing you to credit any excess electricity against future utility bills.

Charge Controller - prevents battery overcharging and prolongs the battery life of your PV system.

In addition, an assortment of balance of system hardware; wiring, overcurrent, surge protection and disconnect devices, and other power processing equipment.

Breaker Panel, AC Panel, Circuit Breaker Panel

The breaker panel is where the power source is joined to the electrical circuits in your home. A circuit is a continuous route of connected wire that joins together outlets and lights in the electric system.

For each circuit there is a circuit breaker. Circuit breakers prevent the appliances on a circuit from drawing too much electricity and causing a fire hazard. When the appliances on a circuit demand too much electricity, the circuit breaker will switch off or trip, interrupting the flow of electricity.

OR

(a), MPPT or **Maximum Power Point Tracking** is algorithm that included in charge controllers used for extracting maximum available power from PV module under certain conditions. The voltage at which PV module can produce maximum power is called 'maximum power point' (or peak power voltage). Maximum power varies with solar radiation, ambient temperature and solar cell temperature.

Typical PV module produces power with maximum power voltage of around 17 V when measured at a cell temperature of 25°C, it can drop to around 15 V on a very hot day and it can also rise to 18 V on a very cold day.

(b), STAND ALONE WIND SYSTEM

Storage is typically implemented as a battery bank, but other solutions exist including fuel cells. Power drawn directly from the battery will be direct current extra low voltage (DC ELV), and this is used especially for lighting as well as for DC appliances. An inverter is used to generate AC low voltage, which more typical appliances can be used with.

> Stand-alone photovoltaic power systems are independent of the utility grid and may use solar panels only or may be used in conjunction with a diesel generator, a wind turbine or batteries

2. Standalone Wind Energy System

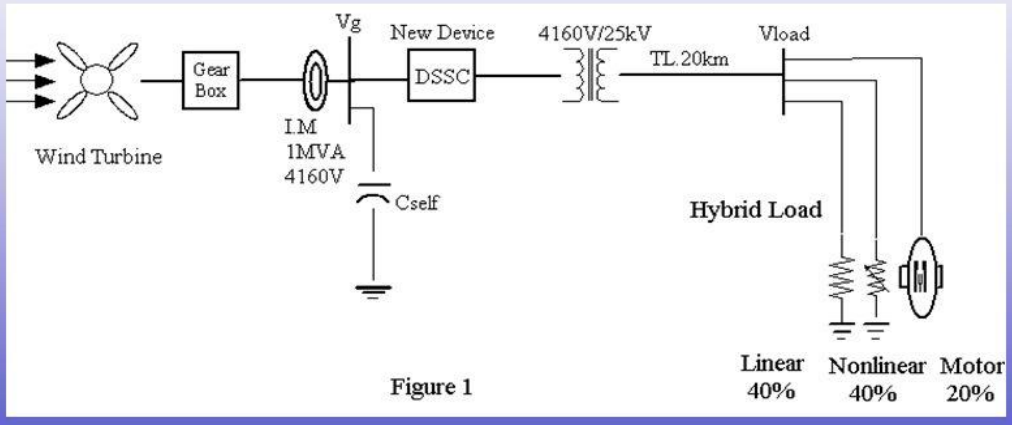


Figure 1

Figure 1 shows Standalone Wind Energy Conversion Scheme Diagram with Hybrid Load and Dynamic Series Switched Capacitor Compensations

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